MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2017/2018

PPH 0125 – MECHANICS

(Foundation in Engineering)

1 JUNE 2018
9:00 a.m – 11:00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages excluding the cover page and the appendices with **FIVE** questions only.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary workings must be shown.

Answer **ALL** questions.

Question 1: [10 marks]

A 8.0-kg mass is placed on a 30 degree frictionless incline plane and is attached to a pulley connected to a hanging mass of 5.0-kg as in **Figure Q1**.

i) Draw a free body diagram showing all the forces acting on the two masses. (2 marks)

ii) In which direction will the system (masses) move if it were released from rest? (2 marks)

iii) Calculate the acceleration of the system. (4 marks)

iv) Calculate the tension in the rope connecting the two masses. (2 marks)

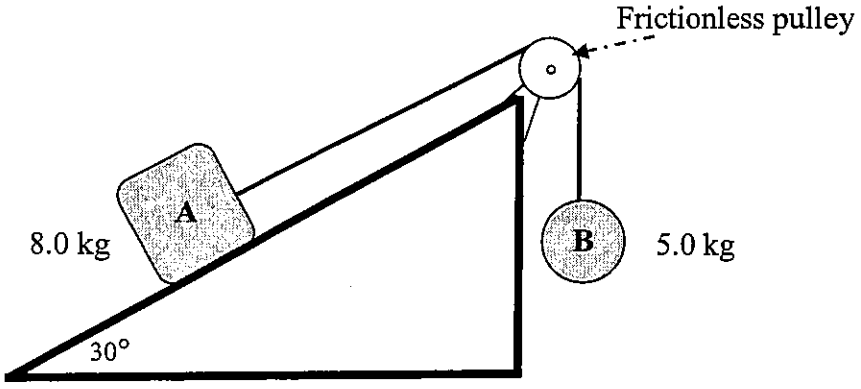

Figure Q1

Continued...

Question 2: [10 marks]

a) A 0.350-m-radius wheels is given an angular acceleration of 0.250 rad/s^2 starting from rest. After the wheels have made 200 revolutions (assume no slippage):

i) How far has the wheel moved?

(2 marks)

ii) What are the final angular velocity and the linear velocity of the wheel?

(2 marks)

iii) When the wheel is rotating at a constant angular velocity of 280 rpm, a constant force of 15.2 N is applied tangential to the rim of the wheel. If the moment of inertia of the wheel is 16.2 kg m^2, how long does it take to stop the wheel from rotating?

(3 marks)

b) Three children are riding on the edge of a merry-go-round that has a mass of 100 kg, radius of 1.60 m, and is spinning at 20.0 rpm. The children have masses of 22.0, 28.0, and 33.0 kg. If the child who has a mass of 28.0 kg moves to the center of the merry-go-round, what is the new angular velocity of the merry-go-round in rpm? Assume the merry-go-round is a disc with moment of inertia of $I = \frac{1}{2}MR^2$.

(3 marks)

Question 3: [10 marks]

a) **Figure Q3** shows four different masses placed at the vertices of a square of side 2.0 m. Calculate the net gravitational force exerted on the 1 kg mass by the other three masses.

(8 marks)

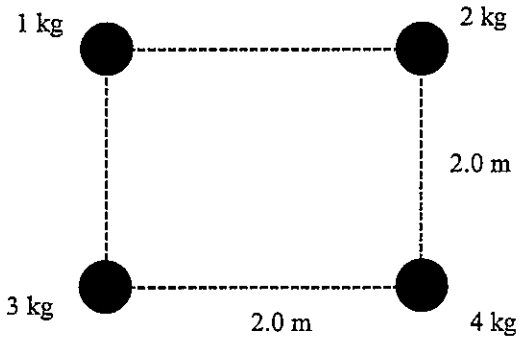

Figure Q3

Continued...

b) A 350 kg lunar lander is on the surface of the moon. Calculate the escape velocity of the lunar lander to escape the gravitational pull of the moon.

(2 marks)

Question 4: [10 marks]

a) A vertical rod 5.0 m long and 0.65 cm^2 of cross sectional area, is compressed by 2.0 mm when a mass of 135.0 kg is placed on top of it.

i) Determine the Young modulus of the rod.

(2 marks)

ii) If we consider the rod to be a spring, within it elastic limit, what is the spring constant.

(1 mark)

b) A solid sphere of radius 1.50 cm floats in oil of density 810 kg/m^3 with two-third of the sphere in the oil.

i) Draw a free body diagram of the forces acting on the solid sphere.

(1 mark)

ii) Calculate the buoyant force that acts on the sphere.

(2 marks)

iii) Calculate the density of the solid sphere.

(2 marks)

iv) If the solid sphere is removed from the oil and placed in a container filled with water of density 1000 kg/m^3, what volume of the sphere is submerged in water?

(2 marks)

Continued...

Question 5: [10 marks]

A mass of 0.2 kg is connected to a light spring of force constant 18 N/m and is free to oscillate with a simple harmonic motion. If the mass is displaced $x = 2$ cm from equilibrium and released from rest,

i) Express the displacement of the motion as a function of time.

(4 marks)

ii) Calculate the time it takes for the mass to reach $x = 1$ cm from equilibrium position after it was released from rest.

(2 marks)

iii) What is the total energy of the system.

(1 mark)

iv) Calculate the kinetic energy and potential energy when the mass is at $x = 1$ cm.

(3 marks)

End of Paper

APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2 /kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^9 N m^2 /C^2
Permittivity of free space	ϵ_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

Earth:

Gravity	=	9.81 m s^{-2}
Radius	=	6.38 x 10^6 m
Mass	=	5.98 x 10^{24} kg

Moon:

Mass	=	7.35 x 10^{22} kg
Radius	=	1.74 x 10^6 m

Sun:

Mass	=	1.99 x 10^{30} kg
Radius	=	6.96 x 10^8 m

Mean distance from:

Sun to Earth	=	1.50 x 10^{11} m
Moon to Earth	=	3.85 x 10^8 m

APPENDIX II

List of Formulas

$y = kx^n$

$\frac{dy}{dx} = knx^{n-1}$

$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $y - y_o = v_o t + \frac{1}{2}gt^2$ $v^2 = v_o^2 + 2g(y - y_o)$ $y - y_o = \left(\frac{v_o + v}{2}\right)t$

$a_c = \frac{v^2}{r}$ $F_g = G\frac{m_1 m_2}{r^2}$ $U_g = -G\frac{m_1 m_2}{r}$ $T^2 = K_s r^3$

$\tau = r \times F$ $\sum\tau = \tau_{net} = I\alpha$ $I = \sum mr^2$ $v = r\omega$

$L = r \times p = I\omega$ $K = \frac{1}{2}I\omega^2$ $|\tau| = |r||F|\sin\theta$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $T_p = 2\pi\sqrt{\frac{l}{g}}$ $T = \frac{2\pi}{\omega} = \frac{1}{f}$ $\bar{y} = \frac{\sum_{i=1}^{N} m_i y_i}{\sum_{i=1}^{N} m_i}$

$x = A\cos\omega t$ $x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $v = \omega A\cos\omega t$ $W_F = |r||F|\cos\theta$

$a = -\omega^2 A\cos\omega t$ $a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $x - x_o = v_o t + \frac{1}{2}at^2$ $v^2 = v_o^2 + 2a(x - x_o)$ $x - x_o = \left(\frac{v_o + v}{2}\right)t$

$W = mg$ $\sum F = F_{net} = ma$ $f_s \le \mu_S F_N$ $f_k = \mu_K F_N$

$p = mv$ $\sum F = \frac{\Delta p}{\Delta t}$ $\Sigma W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $m_1u_1 + m_2u_2 = (m_1 + m_2)v$ $P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $PE_s = \frac{1}{2}kx^2$ $F_s = -kx$ $PE_G = mgy$

$\bar{x} = \frac{\sum_{i=1}^{N} m_i x_i}{\sum_{i=1}^{N} m_i}$ $W_{Fs} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$